Stoller
Hanford Office

DOE-EM/GJ700-2004

C4180
Log Data Report

Borehole Information:

Borehole: C4180			**Site:** 216-Z-7 Crib		
Coordinates (WA State Plane)		**GWL (ft)[1]:** Not available		**GWL Date:**	Not Available
North	**East**	**Drill Date**	**TOC[2] Elevation**	**Total Depth (ft)**	**Type**
Not Available	Not Available	07/02/04	N/A[3]	50	Push

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Welded steel	1.8	6 5/8	5 1/2	9/16	1.8	50

Borehole Notes:

The logging engineer used a caliper to determine the outside casing diameter. The caliper, casing stickup, and inside casing diameter were measured using a steel tape. All measurements were rounded to the nearest 1/16 in. C. Cearlock (Fluor Hanford) provided the casing depth. All logging measurements are referenced to ground surface.

Logging Equipment Information:

Logging System:	Gamma 2A		**Type:** SGLS (35%) 34TP20893A
Calibration Date:	03/2004	**Calibration Reference:**	DOE-EM/GJ642-2004
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Logging System:	Gamma 4L		**Type:** Passive Neutron U1754
Calibration Date:	None	**Calibration Reference:**	None
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	**1**	**2 Repeat**			
Date	07/13/04	07/13/04			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	52.5	20.5			
Finish Depth (ft)	0.5	15.5			
Count Time (sec)	200	200			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
ft/min	N/A	N/A			
Pre-Verification	BA366CAB	BA366CAB			

Log Run	1	2 Repeat			
Start File	BA366000	BA366053			
Finish File	BA366052	BA366058			
Post-Verification	BA366CAA	BA367CAA			
Depth Return Error (in.)	0	0			
Comments	No fine-gain adjustment.	No fine-gain adjustment.			

Passive Neutron (PN) Log Run Information:

Log Run	1	2 - Repeat			
Date	07/14/04	07/14/04			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	0.0	13.0			
Finish Depth (ft)	51.75	18.0			
Count Time (sec)	N/A	N/A			
Live/Real	N/A	N/A			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
ft/min	1.0	1.0			
Pre-Verification	DL042CAB	DL042CAB			
Start File	DL042000	DL042208			
Finish File	DL042207	DL042228			
Post-Verification	DL042CAA	DL042CAA			
Depth Return Error (in.)	N/A	- 0.5			
Comments	No fine-gain adjustment.	No fine-gain adjustment.			

Logging Operation Notes:

Logging was performed with a centralizer installed on the sondes. Pre- and post-survey verification measurements for the SGLS employed the Amersham KUT (^{40}K, ^{238}U, and ^{232}Th) verifier with serial number 082. Maximum log depth exceeded the reported casing depth by approximately 2 ft.

Passive neutron logging was also performed in the borehole to detect neutrons that may be generated by interactions of alpha particles in the soil, or, to a less extent, from spontaneous fission. Pre- and post-verification measurements were acquired using an Am-Be neutron source.

Analysis Notes:

Analyst:	Henwood	**Date:**	07/28/04	**Reference:**	GJO-HGLP 1.6.3, Rev. 0

SGLS pre-run and post-run verification spectra were collected at the beginning and end of the day. All of the verification spectra were within the acceptance criteria. Examinations of spectra indicate that the detector functioned normally during logging, and the spectra are accepted.

Verification spectra using an AmBe neutron source were acquired for the passive neutron logging system. Currently there are no verification criteria established for this system. The counts obtained from the pre- and post- verifications were within 1 percent.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Verification spectra were used to determine the energy and resolution

calibration for processing the data using APTEC SUPERVISOR. Concentrations for SGLS spectra were calculated in EXCEL (source file: G2AMar04.xls). The passive neutron data require no data processing except to convert total counts to counts per second. The casing configuration was assumed as one string of 6-in. casing with a thickness of 9/16 in. to 52.5 ft (total logging depth). No dead time or water corrections were required.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, naturally occurring radionuclides (^{40}K, ^{238}U, and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot that also includes passive neutron measurements is included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it exhibited slightly higher net counts per second.

Results and Interpretations:

^{137}Cs, ^{60}Co, and ^{239}Pu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected at 14.5 ft at a concentration of approximately 0.3 pCi/g. It was also detected at two other depth intervals near its MDL of approximately 0.2 pCi/g. Because ^{239}Pu was also detected at 14.5 ft and ^{239}Pu is often associated with ^{241}Am, consideration was given to the possibility the presumed ^{137}Cs energy peak at 661.66 keV could be attributed all or in part to the 662.40-keV energy peak resulting from the decay of ^{241}Am. A confirming gamma energy peak for ^{241}Am at 722.01 keV was not detected. Furthermore, there is no evidence of ^{241}Pu or ^{237}Np, the parent and daughter, respectively, of ^{241}Am. Therefore, the counts measured in the approximate 662-keV energy peak are most likely the result of the decay of ^{137}Cs with little or no ^{241}Am.

^{60}Co was detected between 30 ft and total depth of the borehole (52.5 ft) with a maximum concentration of approximately 2 pCi/g at 31.5 ft.

^{239}Pu was detected at a single depth interval (14.5 ft) at a maximum concentration of approximately 80,000 pCi/g. Energy peaks associated with ^{239}Pu were detected at approximately 129, 333, 345, 375, 383, 393, and 414 keV. The 375.054-keV energy peak has the highest yield of these energy peaks at 0.0016 percent and was utilized to determine concentration; the 129-keV peak has a slightly higher yield, but the low-energy gamma ray is significantly attenuated by the steel casing and tool housing.

Passive neutron logging was performed in the borehole to detect neutrons that may be generated by interactions of alpha particles with oxygen and other less important elements in the soil or from spontaneous fission. Many transuranic radionuclides decay predominantly by alpha particle emission and the passive neutron system may be useful to identify the existence of transuranic radionculides where no gamma emissions are available for detection. The even number isotopes of plutonium such as ^{240}Pu also decay by spontaneous fission and are thus neutron emitters. There is no calibration for this logging system and the data provided are to be used qualitatively.

The passive neutron detector indicates the highest count rate (approximately 0.5 cps) at 14.75 ft, which approximately corresponds with the depth of the only detection of ^{239}Pu at 14.5 ft. The passive neutron may be detecting the decay of plutonium isotopes. In borehole C4178, which is located approximately 50 ft east of this borehole, a ^{239}Pu concentration was measured at approximately 240,000 pCi/g that corresponds to a passive neutron count rate of 3 cps. On the basis of the relatively lower passive neutron count rate (0.5 cps) in borehole C4180, it is predicted plutonium isotopes would exist at lower concentrations than in C4178; the concentration was 80,0000 pCi/g, one-third of that in C4178. However,

caution should be used when considering this relationship because it is based on only two data points. Other factors such as high gamma flux may affect the counting characteristics of the neutron detector.

The ^{40}K and ^{232}Th logs showed an increase in concentrations at approximately 42 ft, perhaps suggesting a lithology change.

The plots of the repeat logs demonstrate reasonable repeatability of the SGLS data for the natural and man-made radionuclides. The passive neutron data are less repeatable but show enhanced count rates at similar depth locations.

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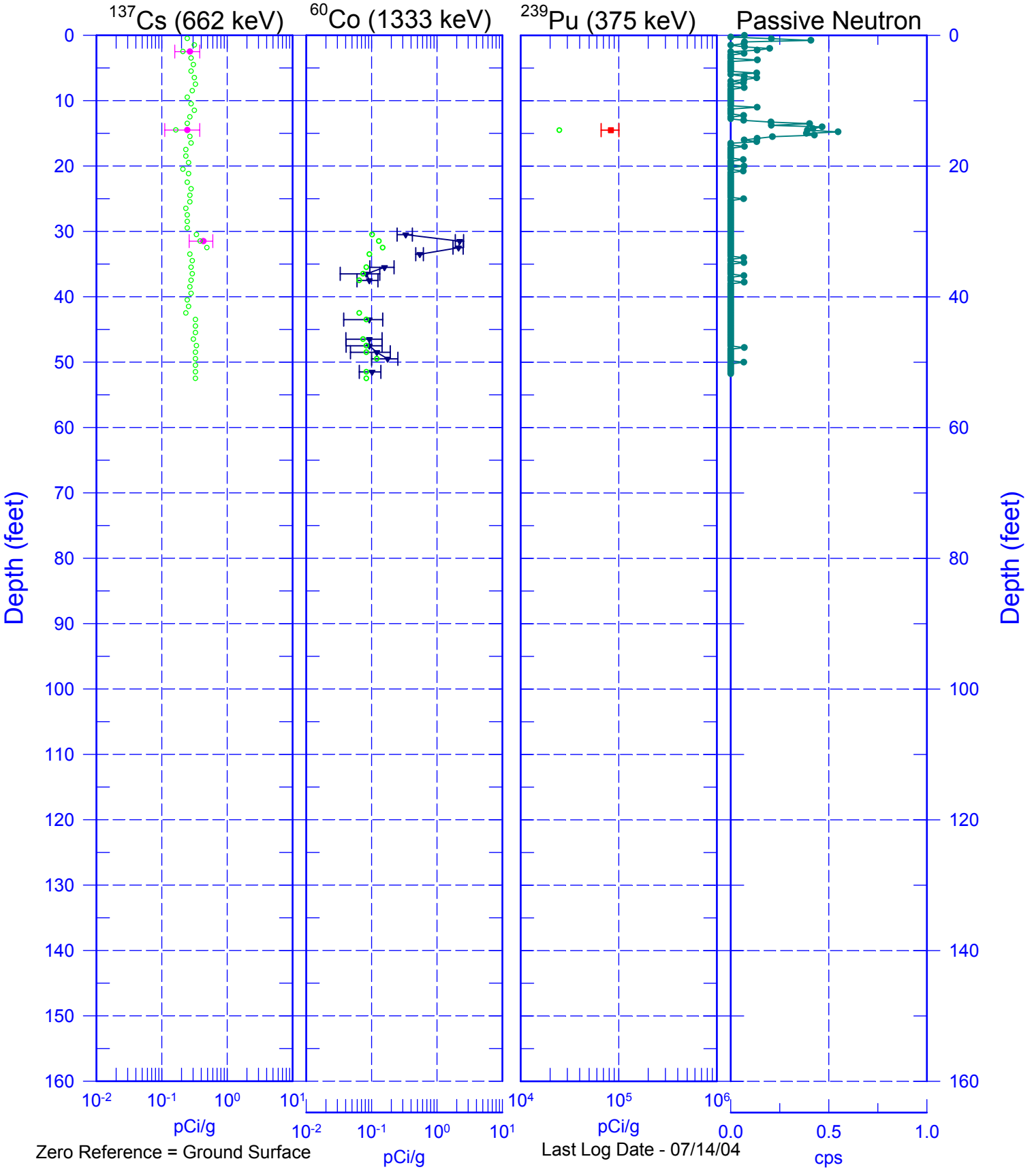
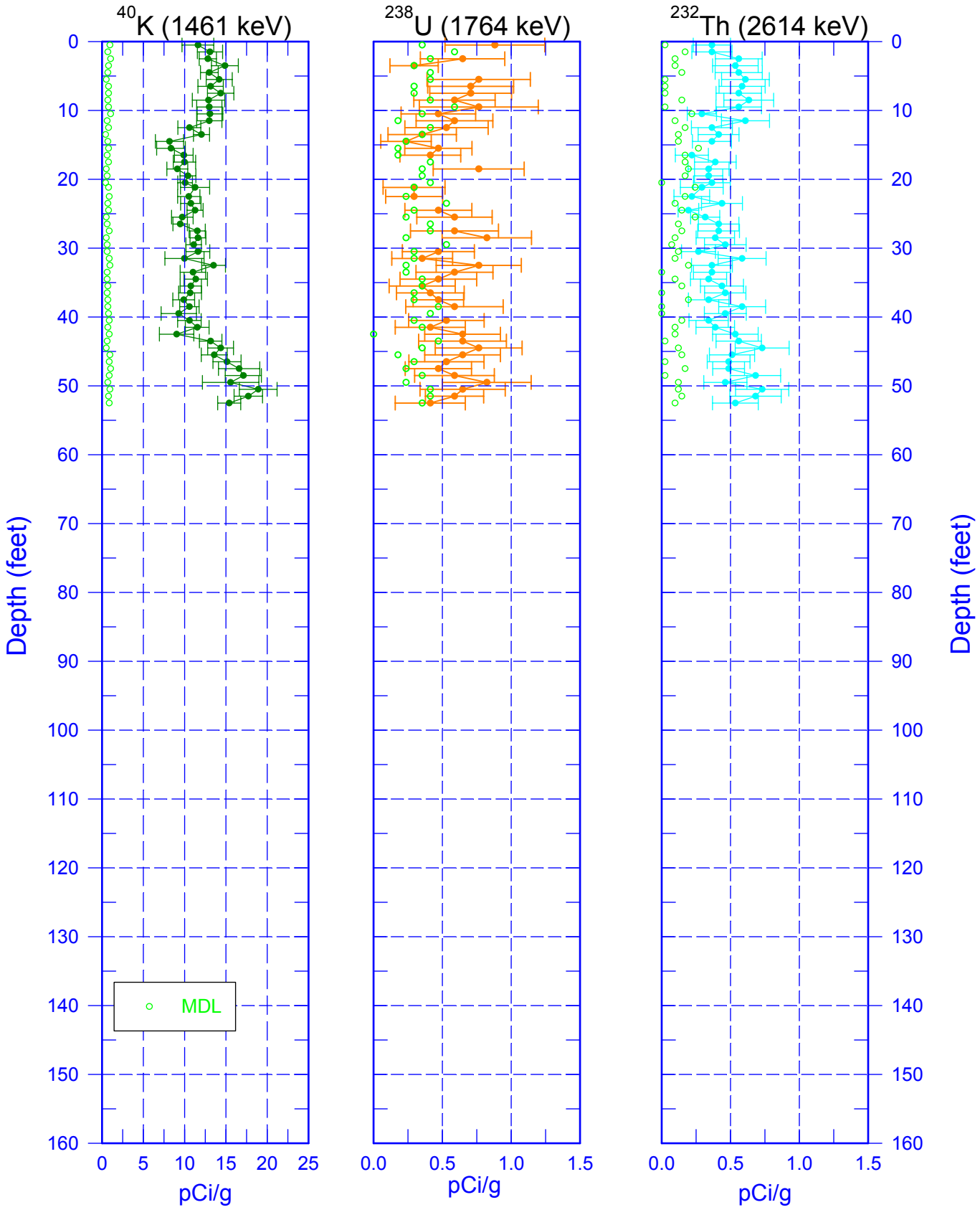
[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not applicable

C4180

Man-Made Radionuclides



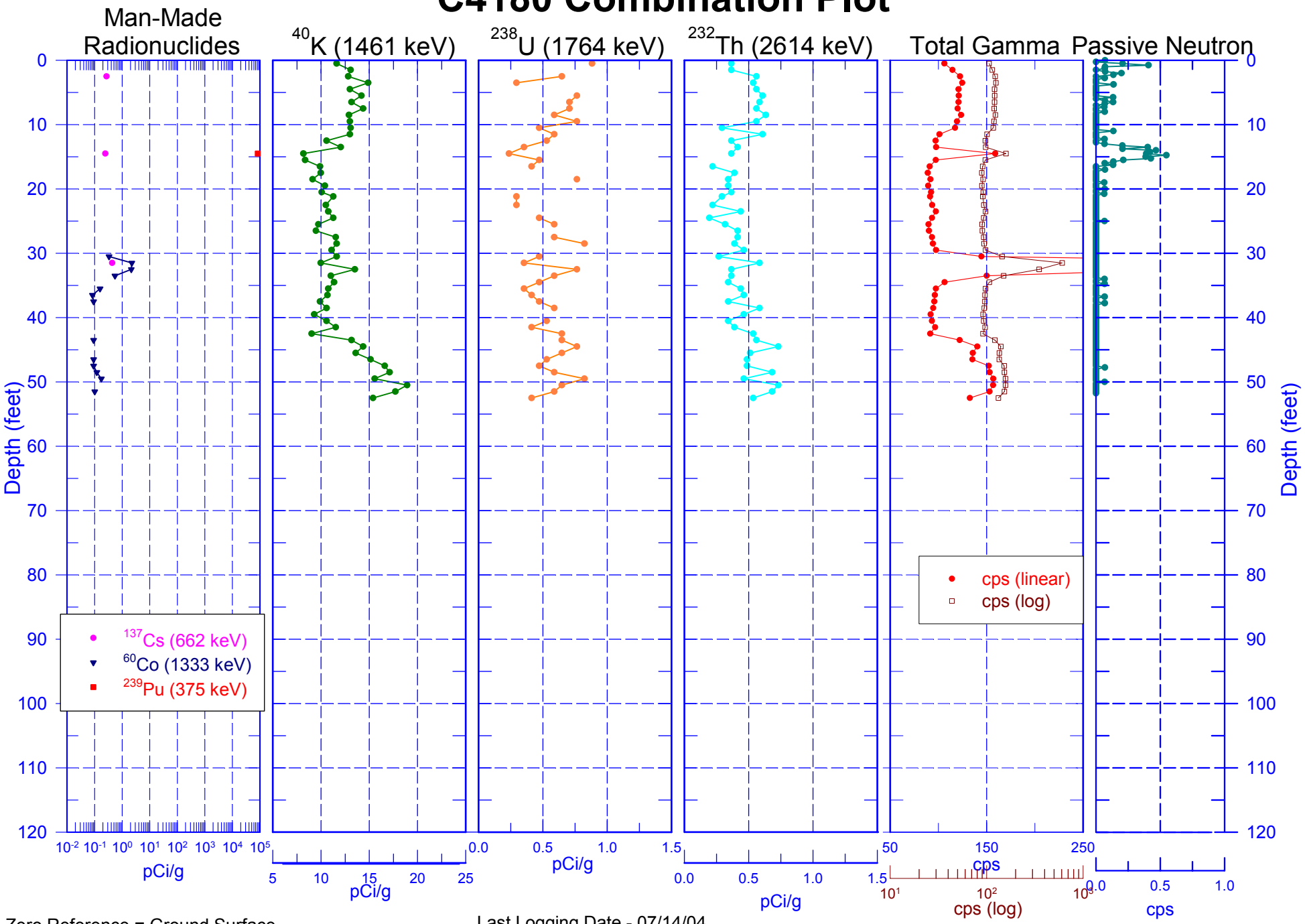
C4180
Natural Gamma Logs



Zero Reference = Ground Surface

Last Log Date - 07/14/04

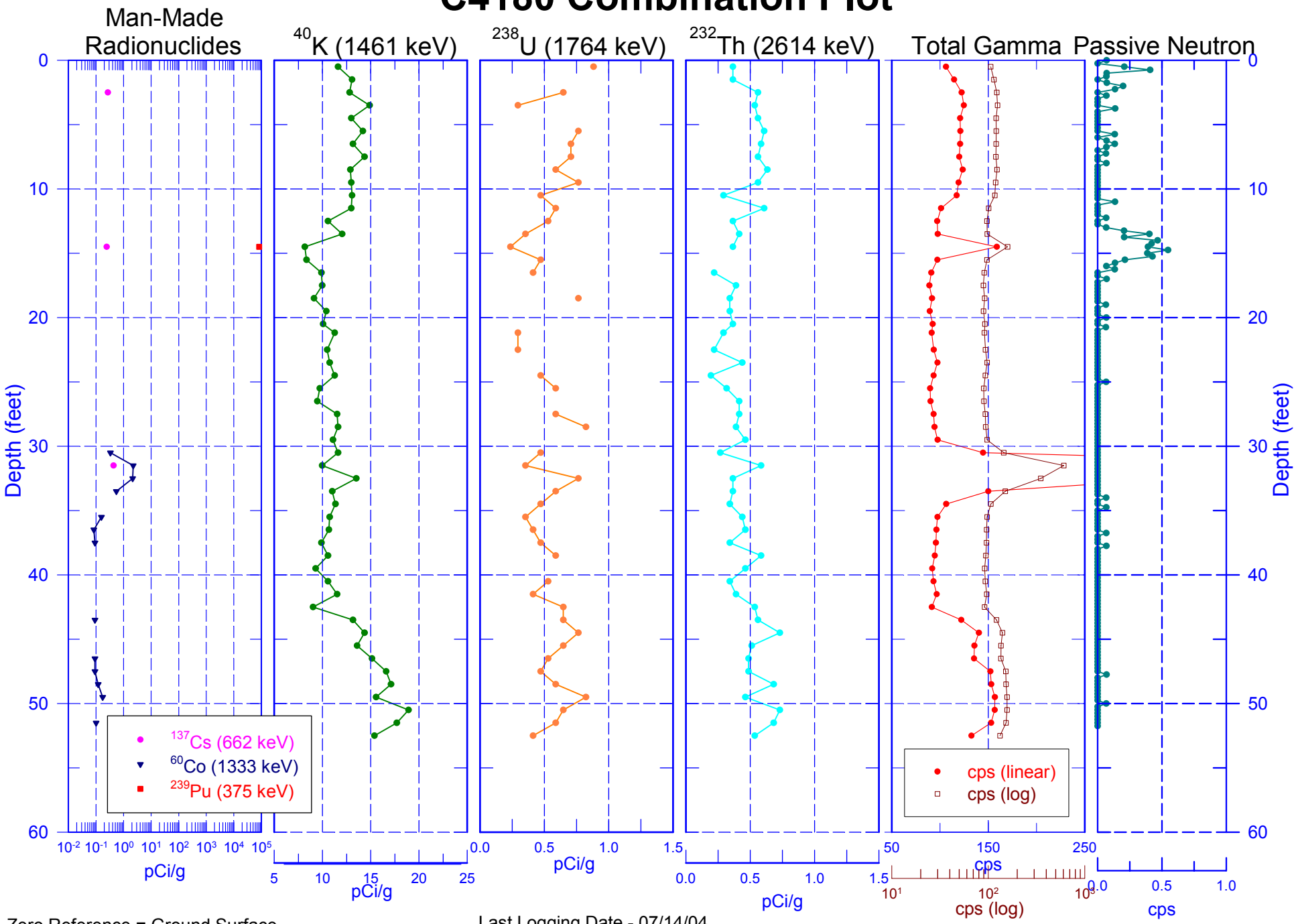
C4180 Combination Plot



Zero Reference = Ground Surface

Last Logging Date - 07/14/04

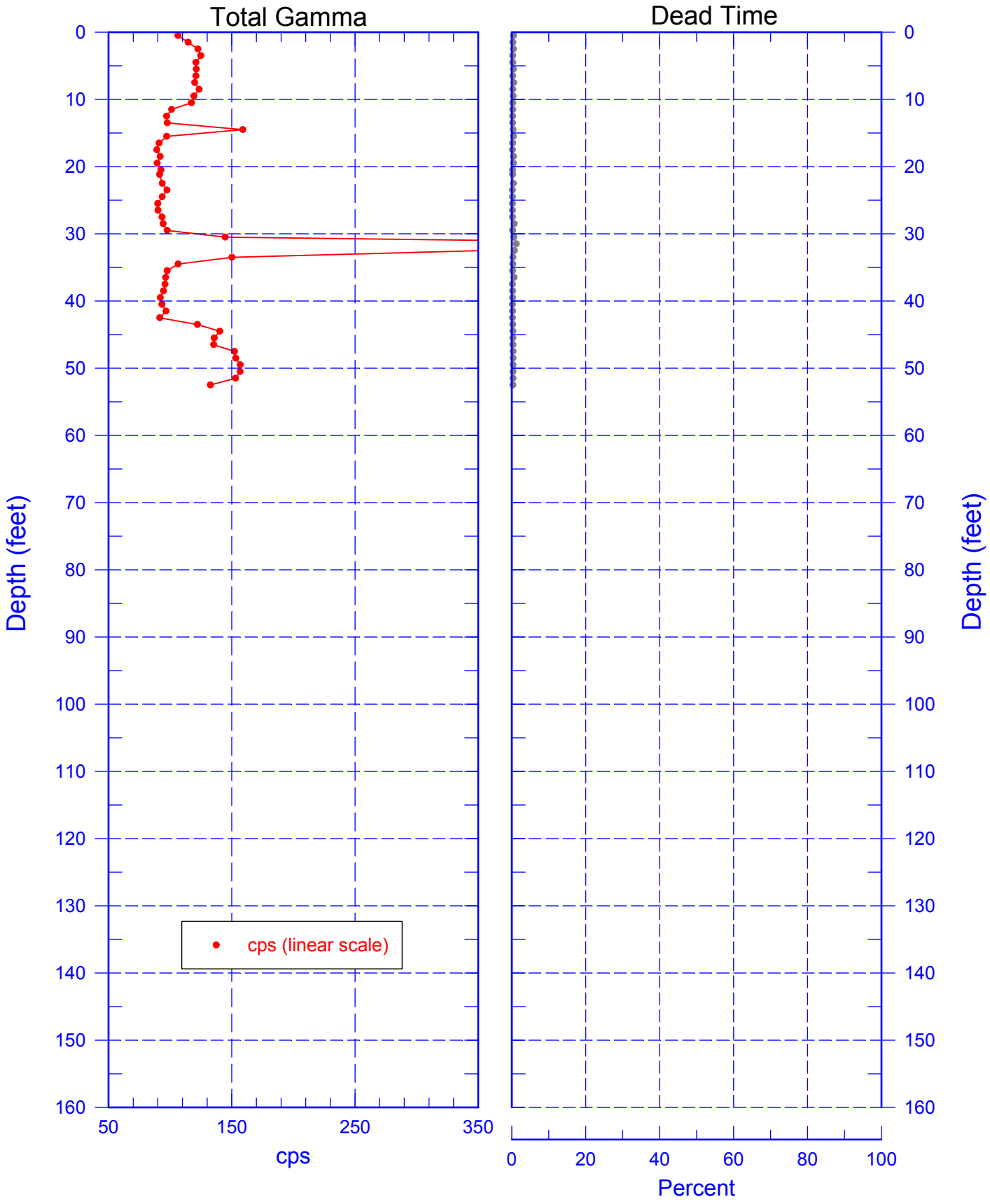
C4180 Combination Plot



Zero Reference = Ground Surface

Last Logging Date - 07/14/04

C4180
Total Gamma & Dead Time



Zero Reference = Ground Surface

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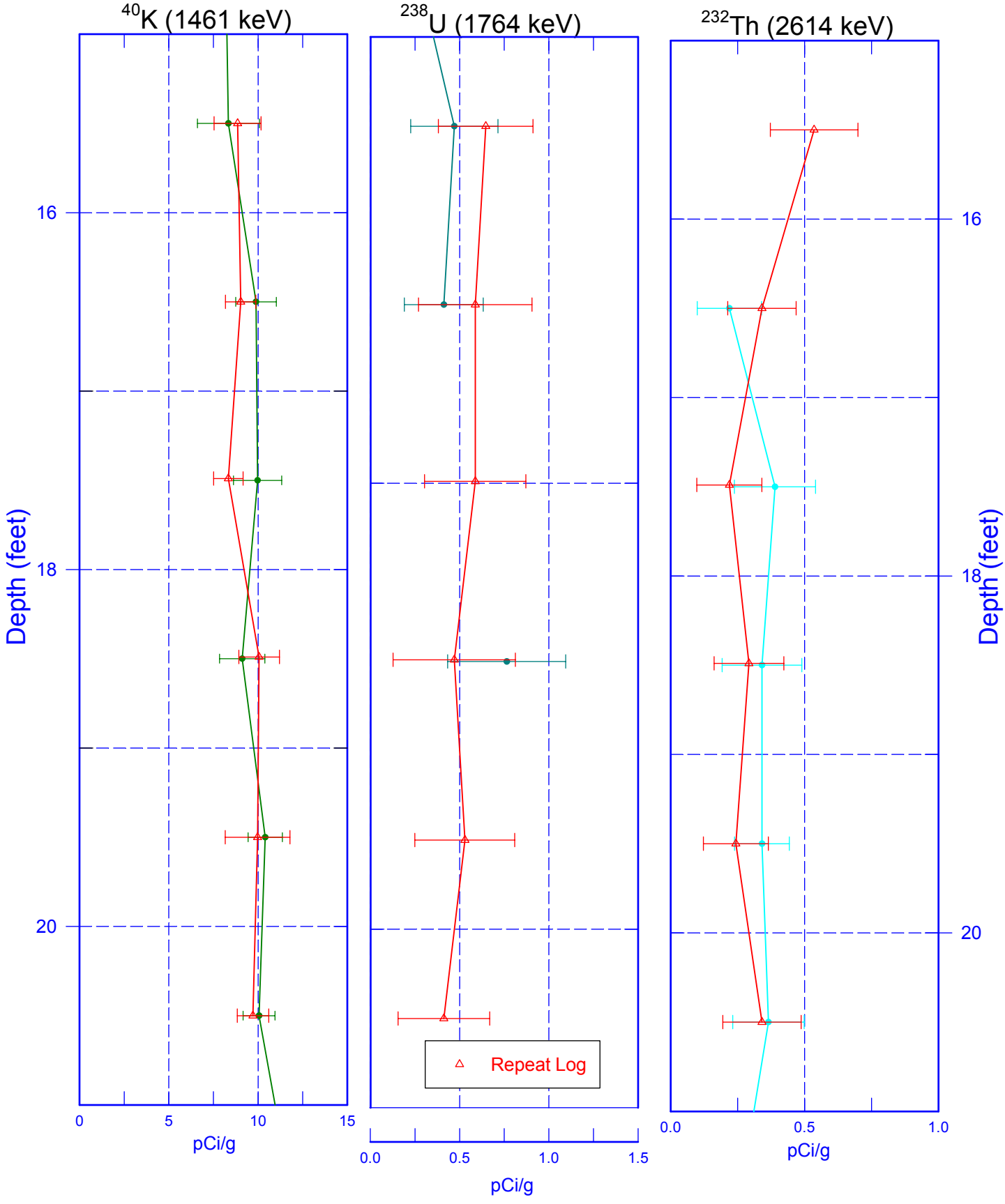
C4180

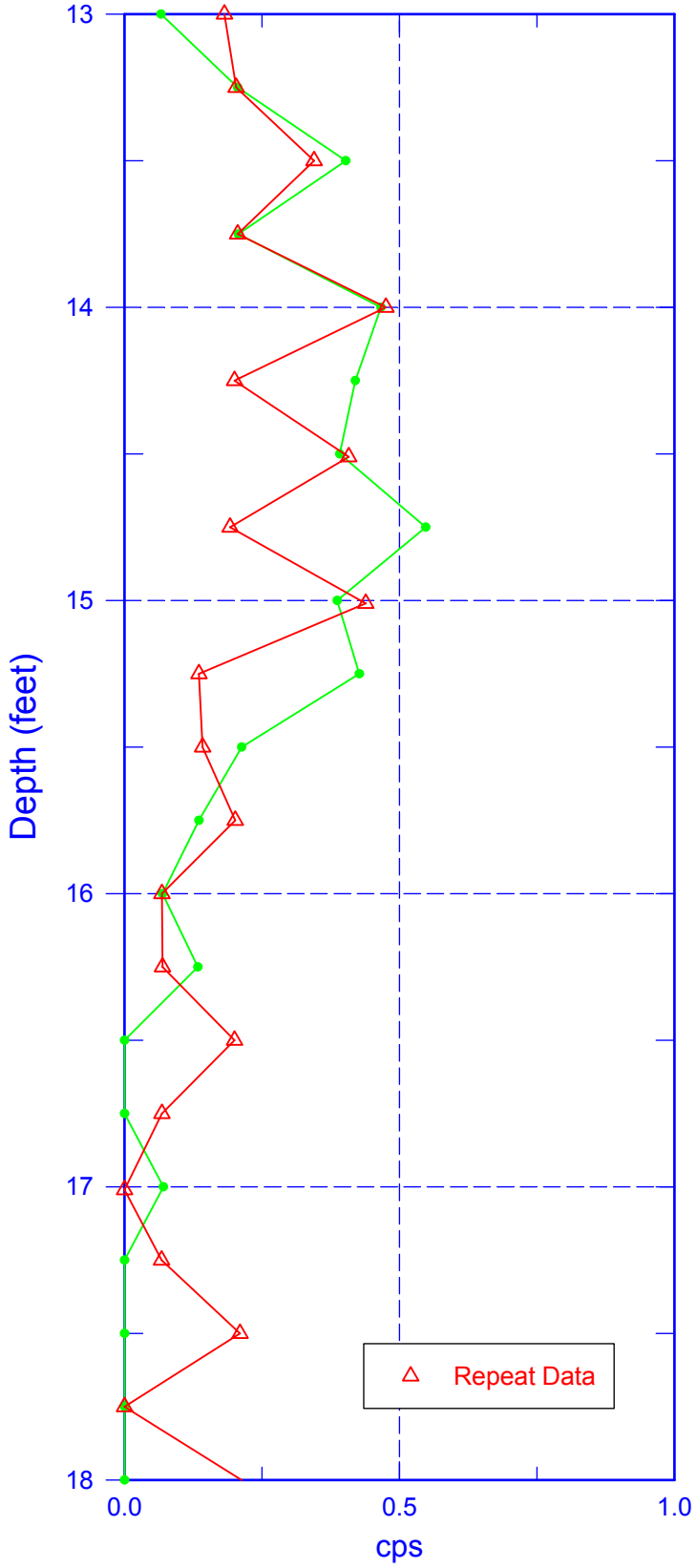
Repeat Section of Natural Gamma Logs



Zero Reference = Ground Surface

Last Log Date - 07/14/04

C4180
Passive Neutron Repeat Section



Zero Reference = Ground Surface

Last Log Date - 07/14/04